Analyzing effectiveness of active learning through project-based learning approach in university level ICT courses

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Abstract

The concept of Active Learning (AL), which has journeyed through multiple research studies over the years, is an important part of the teaching learning process at academic institutions. The present study applies active learning via project-based approaches where students engage in real life projects and solve associated complications with their research, communication, and technical skills. As a case study of effectiveness of project-based learning (PBL), especially in engineering project contexts, the present research is conducted among students studying computer science and engineering at Kathmandu University (KU), Nepal. The key findings of the study suggest that PBL assignments have helped students in their active learning processes. This paper also compares teaching and learning approaches of KU with other IT institutions of Nepal.

Keywords: Active learning, Project based learning, Student centered learning, ICT education

1. Introduction

According to Kokotsaki, Menzies, & Wiggins, (2016), Project-based learning (PBL) has been compared with similar other pedagogical approaches like problem based learning, experiential or collaborative learning. They have recommended six essential characteristics for successful adoption of PBL: effective guidance and support for students, regular teacher support through professional development opportunities, effective group work, balancing didactic instruction with independent inquiry method, continuous monitoring of progress and finally a sense of student choice and autonomy. Hence, PBL has been practiced a long way in modern education and success stories of PBL have been shown in almost every study that follows the active learning procedures.

Active Learning (AL) is a process where students engage in activities that promote higher order learning skills (Bonwell & Eison, 1991). AL has received a good amount of attention from researchers and academicians for several years, and replaced the traditional teaching-learning method. AL differs from traditional learning

methods where students passively receive information from the instructor, does his/her homework or lab work whereas in active learning, the engagement of learners in the learning process is of central focus.

PBL is a practical teaching methodology in which teaching is focused around activities that help students gain practical knowledge together among other learners while creating and testing an industry related or close to industry related project (Sanger &Ziyatdinova, 2014). In engineering context, a project can basically be defined as a work, generally closer to the professional world that will take a specific time scale for its completion and are more directed to application of the gained knowledge (Lacuesta, Palacios, & Fernández, 2009). As PBL is learner centric approach, learners are collaboratively involved in planning, designing, implementing and testing the project in real life situations due to which they create their own knowledge rather than depending on knowledge imposed to them (Giri, 2016). According to Stripling, Lovett & Macko (2009), "Project-based learning is the instructional strategy of empowering learners to pursue content knowledge on their own and demonstrate their new understandings through a variety of presentation modes."

According to Thomas (2000), the characteristics of PBL practices are that they: are central and not peripheral to the curriculum, are focused on driving problems, make students involved in a constructive investigation and are closer to reality. The adoption of PBL is gradually increasing throughout universities of the world for producing graduates that are capable of applying practical application engineering (Sanger &Ziyatdinova, 2014; Thomas, 2000) .

In this study, the authors present their experience of introducing PBL at Kathmandu University, Nepal. Students have developed projects for solving problems of Internet quality measurement and File management system for Namobuddha Municipality. The key findings of the study suggest that PBL has helped students envision how real-life projects work, improve their research, communication, time management and networking skills. These findings have led the researchers to recommend a possible integration of PBL in future teaching-learning sessions especially in engineering project contexts.

2. Methodology

This research used both quantitative and qualitative methods to analyze efficacy of project-based learning in ICT courses. The quantitative model helped the researchers to measure the differences of students' perception in various questionnaires before and after the projects. The qualitative approach helped in perceiving the experiences of students and faculty members in overall completion of this research project. The steps taken to carry this project are discussed in the sections below.

Step 1: Participants Identifications and Initial Data Collection

Firstly, two students' groups, out of 100 students, have been chosen to carry out two different research projects. The students engaged in this process have studied in the fourth semester of the Department of Computer Science and Engineering at Kathmandu University. The questionnaires have been distributed to measure their views on project motivation factors, faculty and students bonding, student abilities, and difficulties faced by students in their academic activities. Likert-scale of 5 points have been used to measure their responses for a particular statement. The detailed questionnaire is attached in the appendix section of this paper. The response set for our questionnaire is listed below.

Step 2: Implementing PBL

Secondly, two courses namely Communication and Networking (COMP 204) and System Analysis and Design (COMP 302) have been introduced where project-based learning methods have been applied to enhance

students' knowledge. Student groups have been taken to Namobuddha municipality where they investigated the current problems that could be solved using IT skills and resources. Two problems have been identified and they were turned into projects namely 'Internet Health Nepal' and 'File Management System'. Students have been supervised by principal investigator and co-principal investigator of this research project who were also course instructors of two aforementioned subjects.

Table 1: A summary of response to the questionnaire

Response Set	1	2	3	4	5
Agreement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Frequency	Never	Rarely	Sometimes	Often	Always
Importance	Not at all important	Slightly important	Moderately important	Very important	Extremely Important
Satisfactions	Not at all satisfied	Slightly satisfied	Moderately Satisfied	Very Satisfied	Completely Satisfied

Step 3: Final Data Collection

After successful completion of projects, students have been evaluated by various faculties and officials of Namobuddha municipality and students' efforts have been highly acknowledged. Participants have been questioned again with a previous list of questionnaires to measure their views regarding specific topics this time. Similarly, participants and course instructors submitted their written reflection about their learning and teaching experiences, respectively.

Step 4: Data Analysis & Reflection Analysis

The variation of data in our Likert scale (before and after) is our subject to analyze and is discussed in results sections. Qualitative analysis has been done to measure the effectiveness of project-based learning where students and course instructors both expressed their individual learning and teaching experiences.

Step 5: Comparison with other Institutions

The same questionnaire set (from step 1) have been distributed among students from other institutions of Nepal who are involved in IT education, namely Islington College, Kantipur City College, Lumbini Engineering College and Everest Engineering College. This process has been carried out in order to understand the teaching and learning approach of various IT institutions of Nepal. The data obtained from this survey have been compared with Kathmandu University initial data.

3. Results and Discussion

3.1 Students' Perception

The study has shown that the technical as well as non-technical skills of the students have been improved after their involvement in PBL. Based on the reflection obtained from the students, the following were some common responses:

'The project gave me an opportunity to work directly for the community and face real life problems.'

'The experience taught me how to face real life problems to develop products that actually provide solutions to the society's

problems.'

'Till this project I didn't know how a real-life system was developed.'

'We regularly visited our supervisor for guidance and to improvise our work'

'It gave me an insight on how to deal with people in real world field as we have just been sitting and looking on the internet without knowing people'

'By the end of the whole process, I got in touch with my skills I hadn't yet discovered and got to sharpen the ones I was familiar with.'

These results indicate that the students had a significant experience working on a real problem-solving environment that helps them increase team coordination, ability to communicate, ability to relate technical aspects to real life problems.

3.2 Questionnaire Distribution and Analysis

Here are some of the major conclusions drawn from the student's responses from questionnaires distributed to them.

- As shown in Fig. 1, 'Solving real world problems and challenges' have been rated the most important motivating factor while selecting the projects whereas factors 'Enhancing programming skills' and 'Fulfilling academic requirements' have received a decrease in priority after being involved in PBL.

- As shown in Fig. 2, frequencies of meeting their respective project supervisor have increased after being involved in PBL.

- As shown in Fig. 2, both the influence of supervisor and an independent student to change the features of the project during the development phase have decreased. This fact was also reflected in students' reflections where students being involved expressed that as they were being involved in real projects solving real world problems, the scope of flexibility became a little restricted compared to working on an academic project for which the main motivation was to enhance programming skills.

- As shown in Fig. 3, student's ability to self-learn, written and oral communication skills and team work coordination improved significantly. One of the main strengths of the PBL process is to improve skills of its learners and judging by the responses of the participants, they have successfully been able to incorporate some of these skills (Thomas, 2000).

- As shown in Fig. 4, the data also reflected that PBL has helped students develop more efficient time management skills. Learning new technical skills and creating a project obviously takes time but PBL creates an environment where students work in groups, share ideas, and learn to break down tasks which makes the time management easier. The serious approach of PBL also enforces students to learn the importance of time management and act accordingly (Mergendoller & Thomas, 2003).

- As shown in Fig. 4, students felt more responsible towards the project than they did on their previous academic project involvement as PBL demands more and more from its participants involved in the project. Students were encouraged to think, brainstorm, work together and come up with new ideas.

- As shown in Fig., individual student's freedom of action was restricted after being involved in the PBL process. Even though students at their early phases of learning would like to experiment and play

around with new ideas regarding the project and add creativity, PBL restricts them to do so at a certain level as they have been dealing with real world problems.
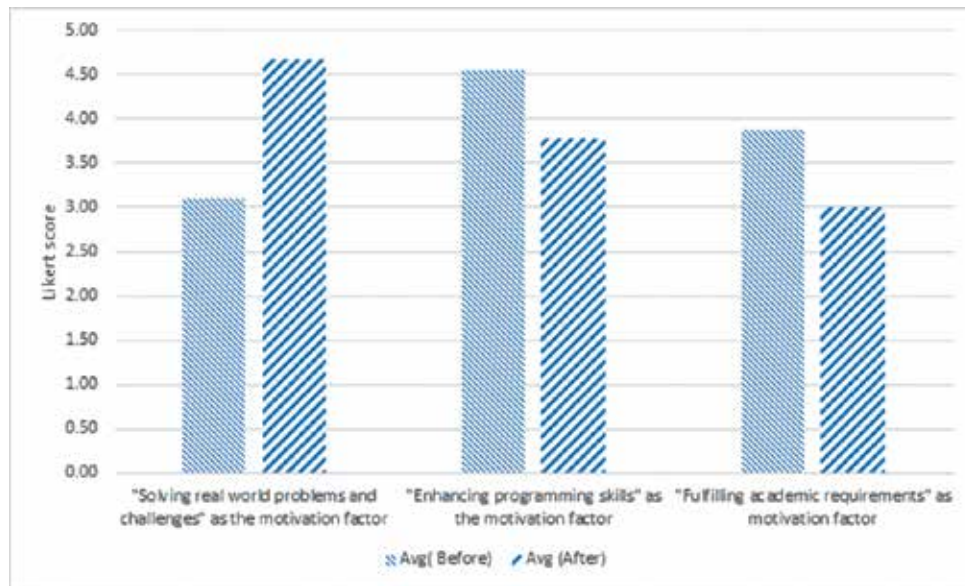
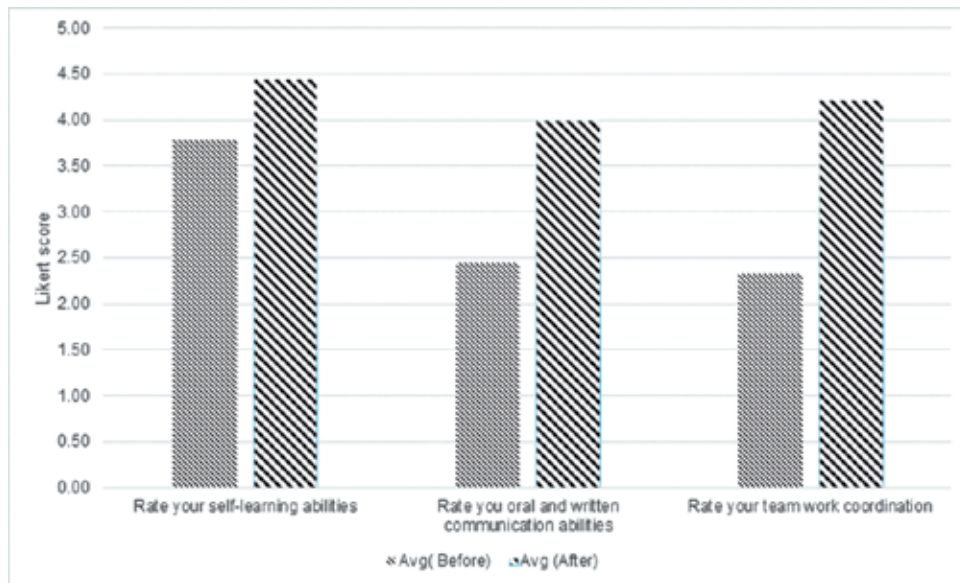**Figure 1**: Comparison of before vs after Likert scores of the students regarding project motivation factor
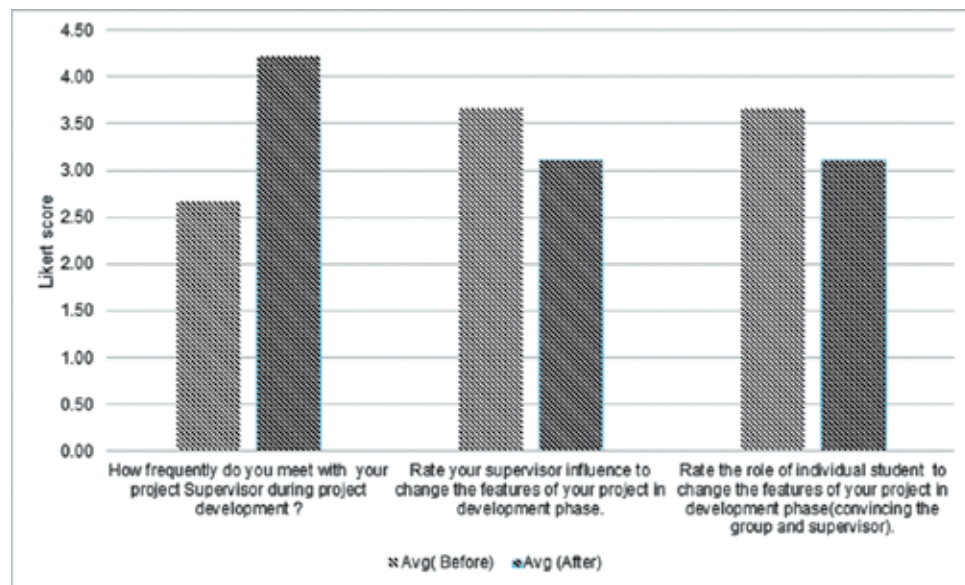

Figure 2: Comparison of before vs after Likert scores of the students regarding faculty and student's bonding

3.3 Faculties' Perception

The course instructors have used almost similar kinds of approaches to involve their students in PBL with the intention to measure the activeness of their students in each phase. In a nutshell, the phases have been divided into requirement, analysis and implementation, along with the testing phase. It has been seen from the faculty perspective that each group has been dedicated and enthusiastic because they have been dealing with real life problems. Unanimously, it can be concluded that students and faculty bonding have been strong and harmonious during the course conduction. And students' self-abilities have also been increased due to involvement in PBL.

Figure 3: Comparison of before vs after Likert scores of the students regarding student abilities
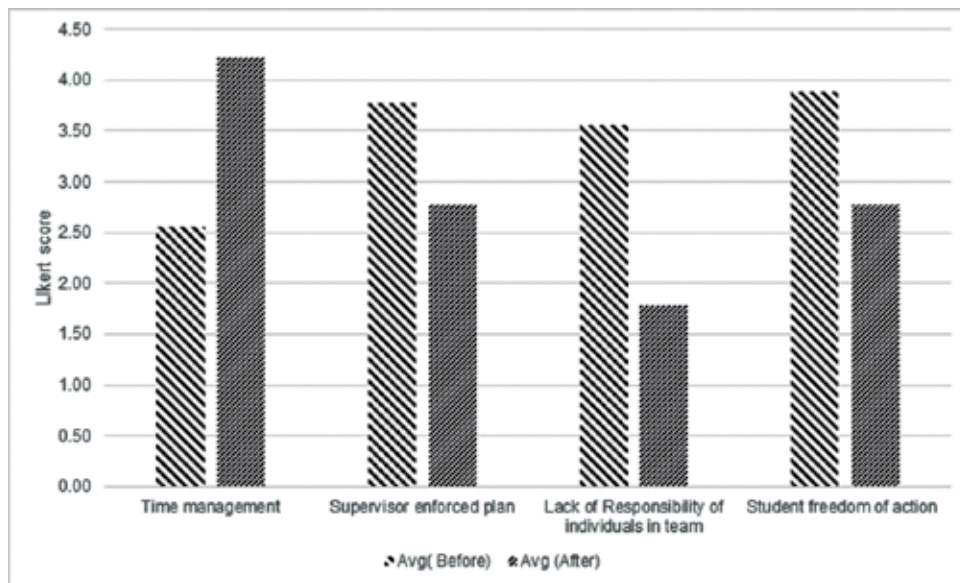
Figure 4:Comparison of before vs after Likert scores of the students regarding difficulties remarked by students while doing the project

### 3.4 Comparison with Other Institutions

In Figures (5-17), the comparisons between average Likert scores have been made between KU students and students from other institutions. As shown in figures, the average difference between the Likert scores turned out to be very low (±0.5 out of 5 max Likert score). So, due to this 10% of difference, it has been concluded that the teaching methodology and learning approach followed in KU and other institutions are similar in nature.
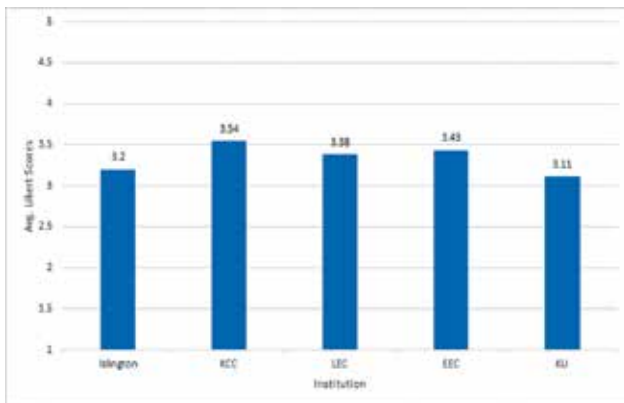
Figure 5: Comparison of average Likert scores of all institutions regarding "Solving real world problems and challenges" as motivation factor for project
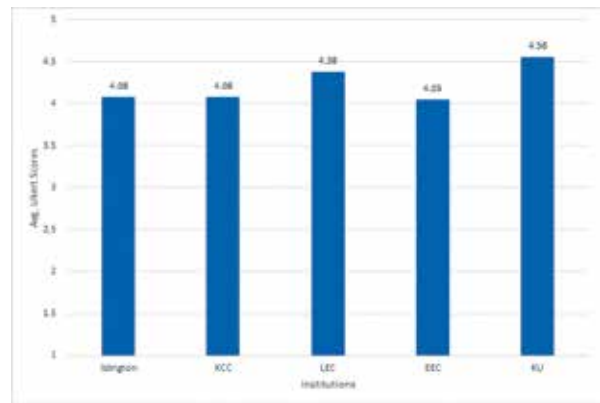
Figure 6: Comparison of average Likert scores of all institutions regarding "Enhancing programming skills" as motivation factor for project
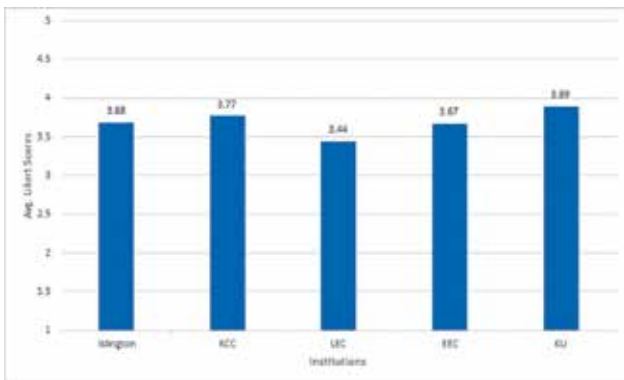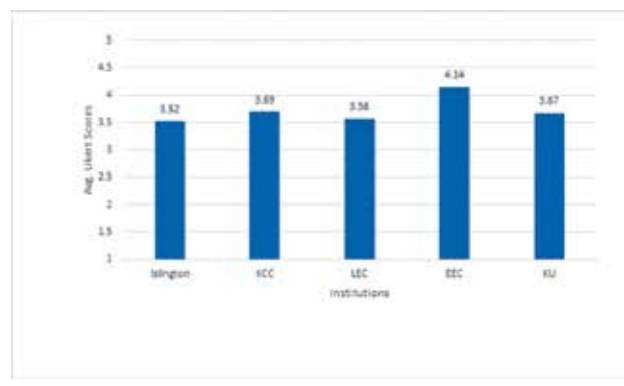

Figure 7: Comparison of average Likert scores of all institutions regarding "Fulfilling academic requirements" as motivation factor for project
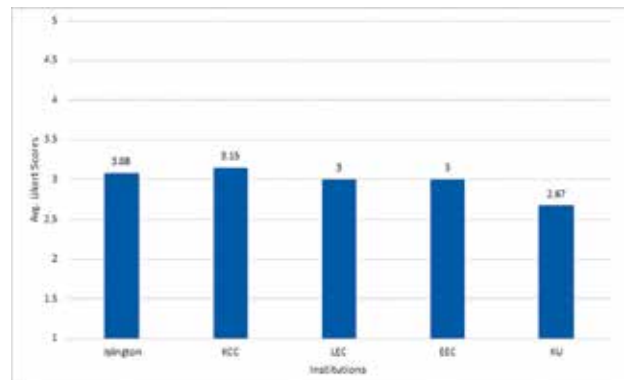
Figure 8: Comparison of average Likert scores of all institutions regarding their supervisor visit frequency
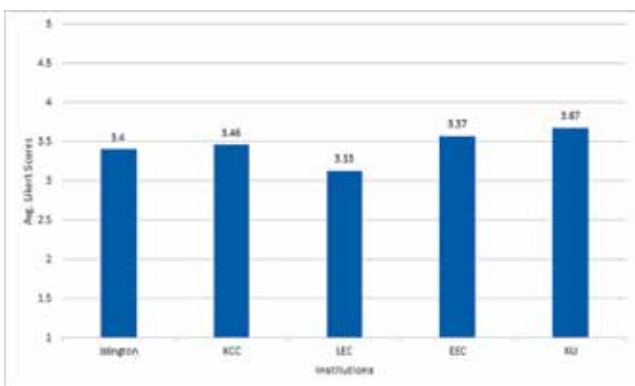
Figure 9: Comparison of average Likert scores of all institutions regarding supervisor influence to change the features of the project in development phase

Figure 10: Comparison of average Likert scores of all institutions regarding individual student's influence to change the features of the project in development phase
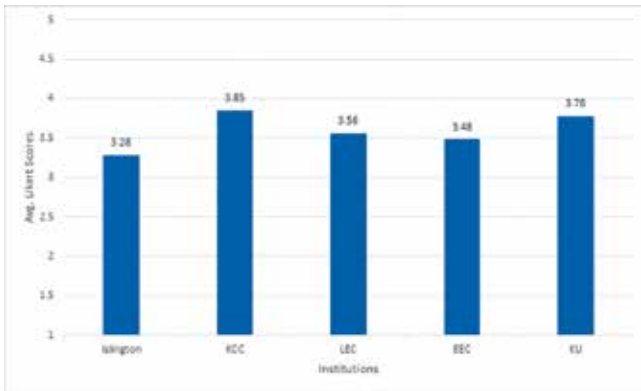
Figure 11: Comparison of average Likert scores of all institutions regarding their self-learning abilities
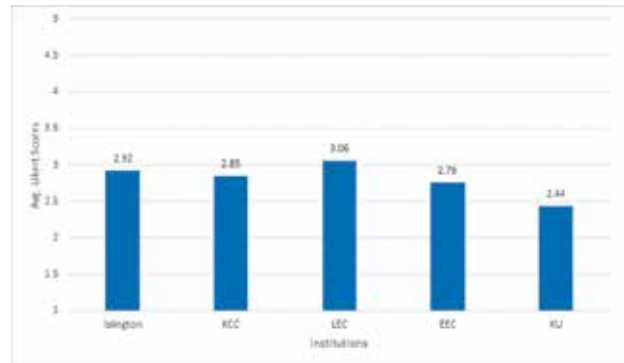

Figure 12: Comparison of average Likert scores of all institutions regarding their oral and written communication skills
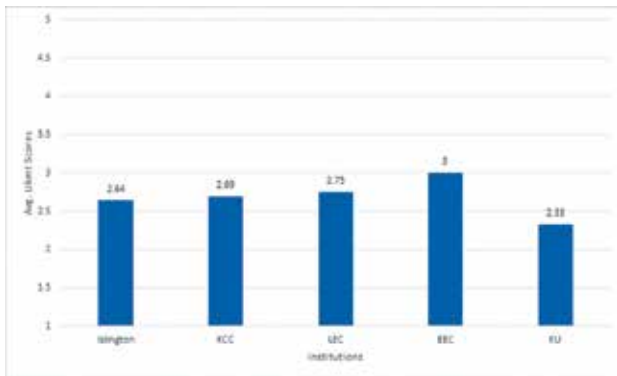

Figure 13: Comparison of average Likert scores of all institutions regarding their team work coordination
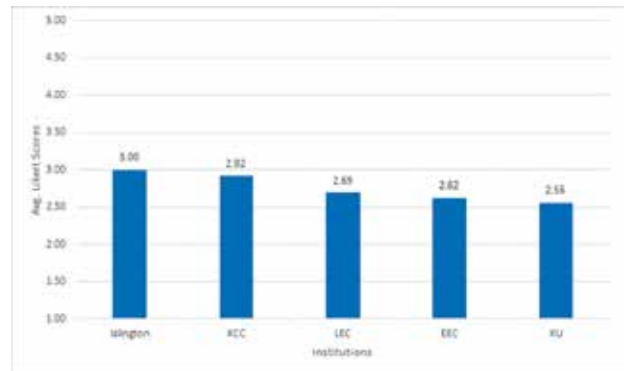

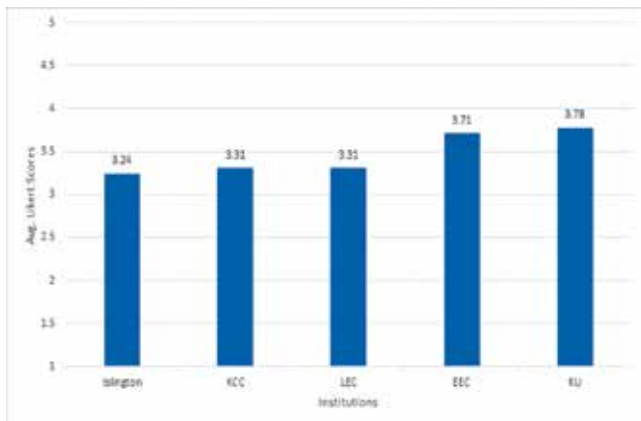**Figure 14:** Comparison of average Likert scores of all institutions regarding time management

Figure 15: Comparison of average Likert scores of all institutions regarding supervisor enforced plan
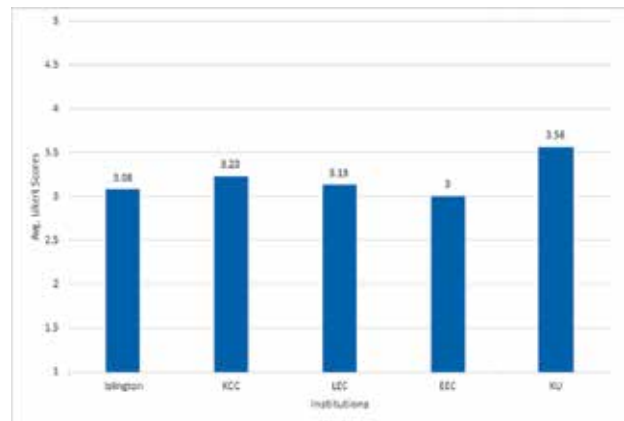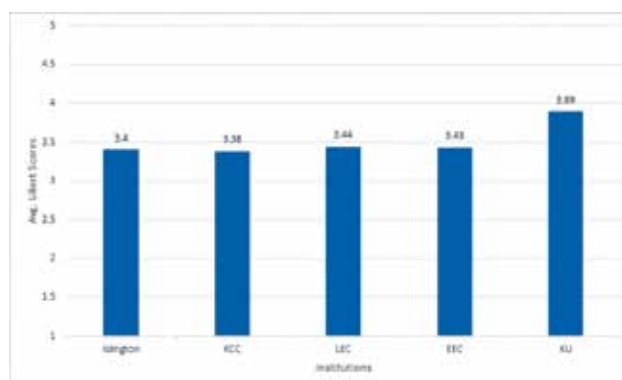

Figure 16: Comparison of average Likert scores of all institutions regarding lack of individual responsibility

Figure 17: Comparison of average Likert scores of all institutions regarding student freedom of action

4. Conclusions and Recommendations

Active learning through a project based approach have been introduced and implemented for ICT courses at the Department of Computer Science and Engineering, Kathmandu University. The teacher-centric course delivery mode in comparison to PBL has been discussed as deprecated for meeting the 21st century learner skills. In general, both students and faculty members responded positively towards this new approach. Students' enthusiasm for solving real world problems has been visible through self-learning abilities, oral and written communication skills, teamwork coordination and time management skills have been increased due to implementation of project based learning approach. On the other hand, fulfilling academic requirements, supervisor influence and enforced plan, lack of responsibility towards individual student and student freedom of action have been given less priority after implementing PBL. Also, it has been seen that the level of challenges that the students have to tackle are almost the same while comparing with other IT institutions of Nepal. In this regard, we can recommend the use of PBL for increasing the effectiveness of learning approach in academic contexts where the universities and educational institutions should be open towards change, exploring new ways of how to improvise teaching learning so that they can produce more confident and competent ICT graduates.

Acknowledgements

Conflict of Interests

Not declared by authors.

Appendix: Questionnaire

(All the questions expect answers in Likert scale: 1-5. The description of response set is explained in Methodology section)

Project Motivation Factors

- How would you rate "Solving real world problems and challenges" as the motivation factor while selecting the projects?

- How would you rate "Enhancing programming skills" as the motivation factor for your projects?

- How would you rate "Fulfilling academic requirements" as motivation factor of your projects?

Faculty & Students Bonding

- How frequently do you meet with your project Supervisor during project? development?

- Rate your supervisor influence to change the features of your project in development phase.

- Rate the role of individual student to change the features of your project in

development phase (convincing the group and supervisor).

Student Abilities

- Rate your self-learning abilities

- Rate you oral and written communication abilities

- Rate your team work coordination

Difficulties remarked by students while doing project

- Time management

- Supervisor enforced plan

- Lack of Responsibility of individuals in team

- Student freedom of action

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